

*SERDP/ESTCP Workshop
Surface Finishing & Repair Issues for
Sustaining New Military Aircraft*

*Fiesta Resort & Conference Center, Tempe, AZ
Feb 26-28, 2008*

Pre-Coated Fasteners

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• Problem

- Military standards require permanently installed fasteners to be treated with a corrosion-inhibiting, “wet” sealant prior to installation to meet the stringent corrosion performance required by the military aerospace operational environment.
- The process is expensive, time consuming, subject to technician error, and requires the use of an environmentally hazardous sealant.
- Removal and replacement of “wet installed” fasteners by field and depot technicians is labor intensive, leading to increased down time for aircraft repairs.



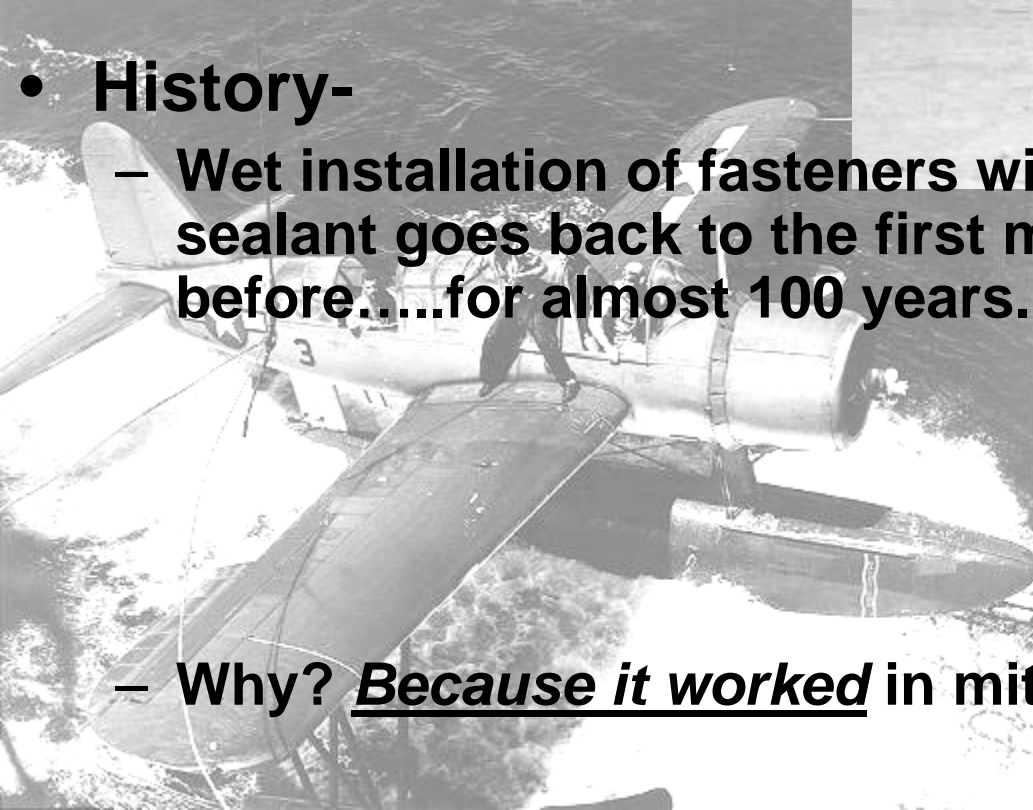
• Objectives

- Dem/Val laboratory and field performance of a candidate pre-coated/self-sealing fastener technology on Navy/USMC aircraft in operating environments and compare to existing practices
- *Deliver a qualified precoated aluminum fastener for fleet use*



Why Wet Install?

- Prevent crevice corrosion around fastener head that leads to filiform corrosion
- History-
 - Wet installation of fasteners with a type of chromated sealant goes back to the first metal Navy Aircraft and before.....for almost 100 years.
 - Why? Because it worked in mitigating corrosion.



Impact to Fleet/Issues

- **Equivalent to and/or improved corrosion protection from a “dry” ready-to-use fastener**
- **Elimination of hazardous solvents and reduction in hazardous waste**
- **Reduce maintenance and corrosion repair cost**
- **Simplifies installation (eliminate wet installation), reducing installation time and cost**
- **Eliminates human element of current sealant process resulting in uniform watertight seals reducing airframe corrosion**
- **Increase aircraft/vehicle readiness level**



- **Performance**
 - Corrosion protection
 - Visual difference
 - Neutral environmental impact
- **Cost**
 - Low impact
- **Production/manufacture**
 - High volume manufacturing
- **Logistics**
 - Shelf life



Project Overview

Initial Candidate Coated Fasteners

Surface Coatings



Magnesium
Rich Primer -
dry

Hi-Cote (phenolic
based aluminum
coating)

Magni 565 (Zn-
rich basecoat
w/Al-rich topcoat)

FluorKote1
(fluoropolymer
coating)

Xylan 1424
(waterborne, dry-
film lube with
PTFE)

ND Microspheres
(microcapsules of
epoxy resin)

Xylan 1020
(similar to
Xylan 1424)

Gasket



NySeal (pre-
applied
uncured
sealant)

Control #1



no coating Cr Conversion
only

Control #2

Plain FastenerWet
Sealed/polysulfide sealant

SBIR PH II



SMRC-Quickseal/pre-applied
non-cured sealant

METSS

Hybrid w/ (Nyseal) Gasket



Magni 565 & Nyseal



Hi-Cote & Nyseal

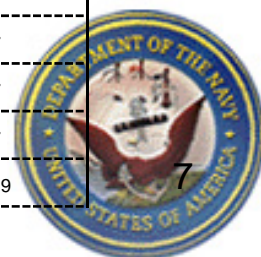


Xylan 1424 w/ Nyseal



Test Panel & Fastener Matrix – Riveted Panels

	ID	Test Method	Comments	Panel Sets			
	A	Salt Fog Atmosphere Per ASTM B117	Phase I Down Selection	51			
	B	Salt/SO2 Fog Atmosphere Per ASTM G85-A4	Phase I Down Selection	51			
	C	Beach Exposure Testing	Long Term Observation to Correlate to Salt & S02	17			
	ID	Coating/Installation Method	Comments	NSF	SO2	Beach	Total Panels
1	A	Wet install – current method	Baseline	3	3	1	7
2	B	Primer Mag Rich - Dry	Dry installed	3	3	1	7
3	C	Hi-Kote 1	Phenolic based aluminum coating	3	3	1	7
4	D	FluorKote1 (blue)	Fluoropolymer coating	3	3	1	7
5	E	Xylan 1070 (black)	similar to 1424	3	3	1	7
6	F	Xylan 1424 (blue)	Waterborne, dry-film lube with PTFE	3	3	1	7
7	G	Magni 565	Zn-rich basecoat w/Al-rich topcoat	3	3	1	7
8	H	ND Microspheres (yellow)	Unknown - waiting recommendation	3	3	1	7
9	K	NySeal (green)	Preapplied sealant	3	3	1	7
10	J	NySeal & Magni 565	Hybrid	3	3	1	7
11	I	NySeal & Hi-Kote	Hybrid	3	3	1	7
12	L	NySeal & Xylan 1424	Hybrid	3	3	1	7
13	M	SMRC Product (gray)	Preapplied sealant 2001	3	3	1	7
14	N	METSS Product (brown)	Preapplied sealant	3	3	1	7
15	O	Contro, Plain Rivets		3	3	1	7
16	P	Plastisol		3	3	1	7
17	Q	AvDEC tape seal	Sandwich the AvDEC tape	3	3	1	7
			Totals	51	51	17	119

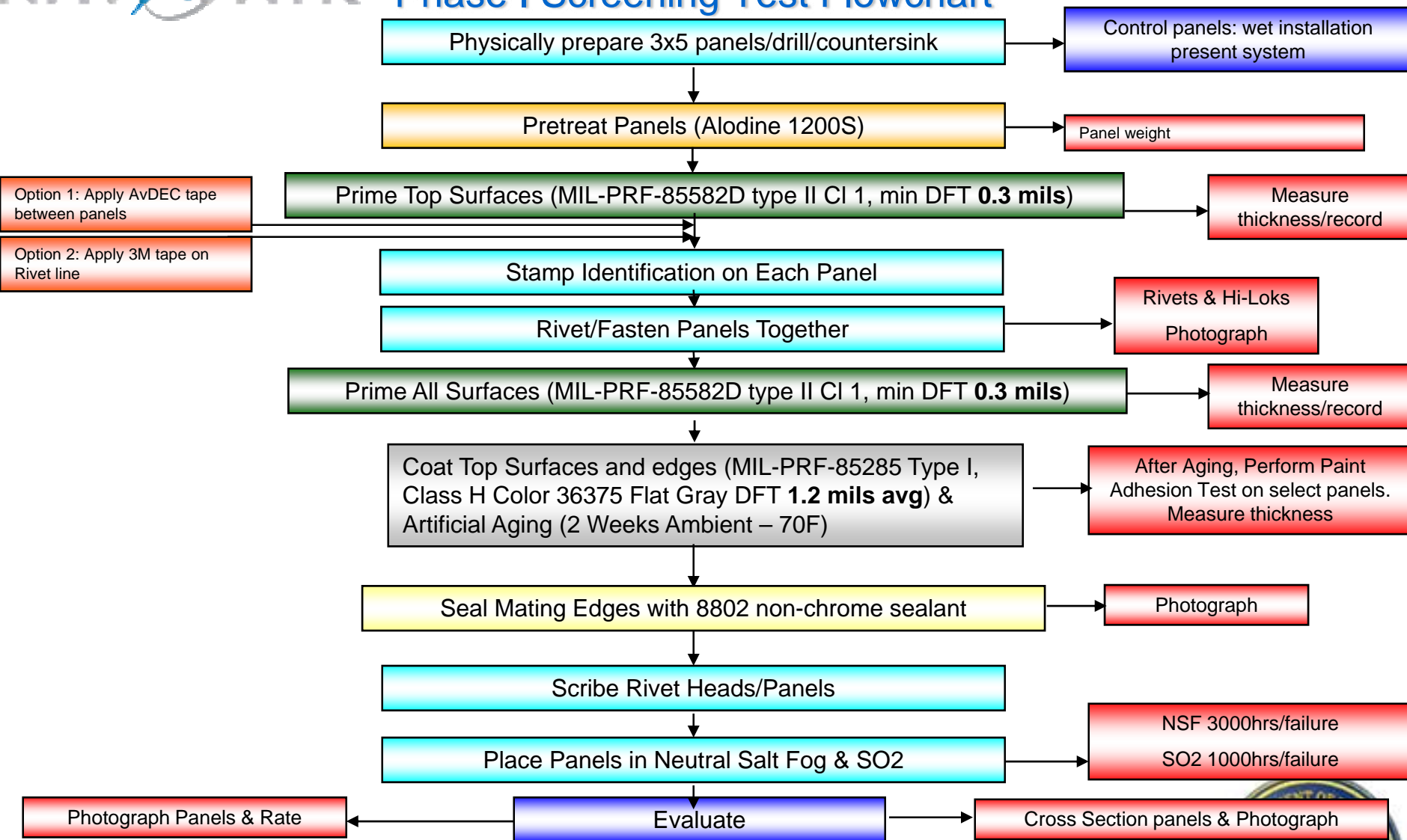


Testing Summary

- **Phase I: Initial Screening testing**
 - Corrosion only
 - Various coatings, tapes, surface treatments for dry installation
 - Evaluate using Aluminum Countersunk Rivets
 - Current chromated primer/pretreatment used for evaluation
- ***Downselect***
- **Phase II: Final Screening testing**
 - Retest using non-chrome pretreatment and non-primer panel setup
 - Nonchrome fastener
 - Fluids compatibility
 - Physical/mechanical testing
 - Leak Testing
 - On-Aircraft testing
- **Phase II A:**
 - Start steel, Hi-lok[™] & titanium fasteners



Phase I Screening Test Flowchart

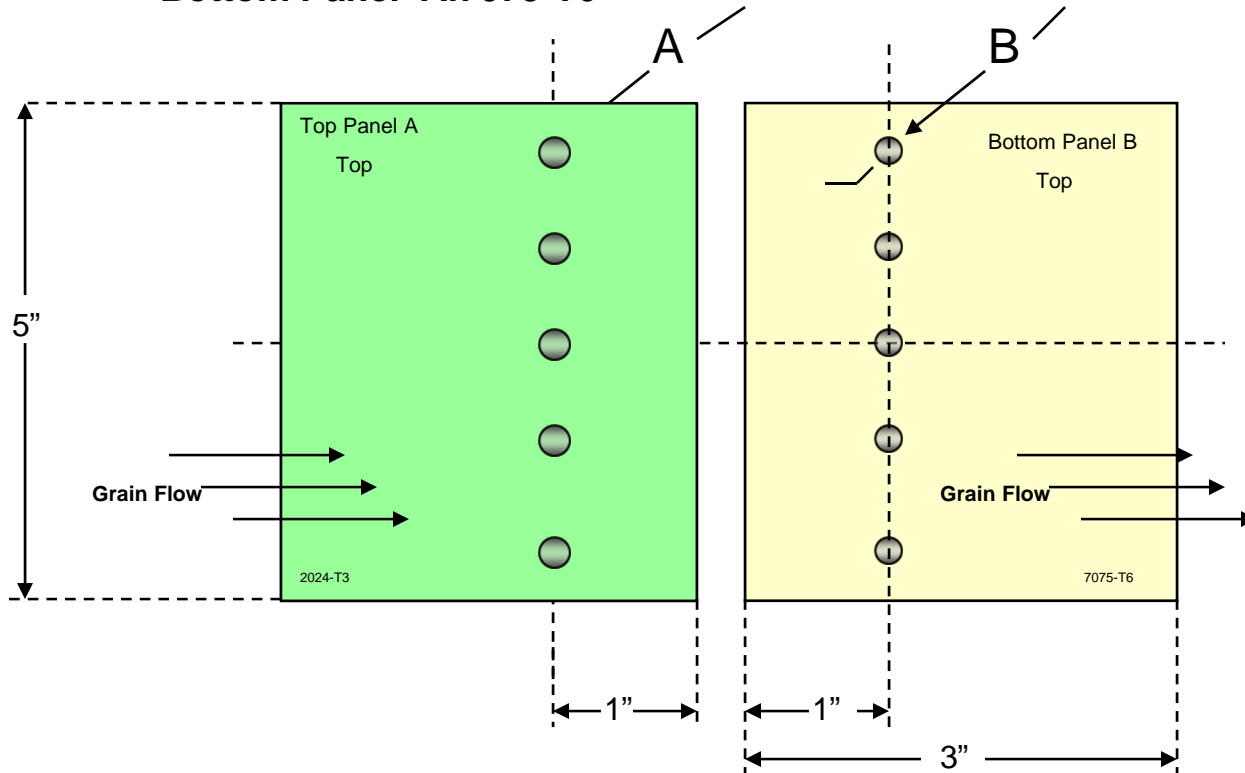


Test Panel Preparation/Pretreatment

Fasteners – Al 2117-T4 (chromated)

Top Panel- Al 2024-T3

Bottom Panel- Al7075-T6



Note A: Top Panel 2024-T3, Dimensions 3in wide x 5in length x 0.25in thick, Countersink 0.25 in 5 Places, starting center at 0.5 inches from short side edge – 1 inch in from long side edge, then drill 1 inch apart on center. Drill through after counter sink 0.1875 inch diameter.

Note B: Bottom Panel 7075-T6, Dimensions 3in wide x 5in length x 0.25in thick, 5 Places, starting center at 0.5 inches from short side edge – 1 inch in from long side edge, then drill 1 inch apart on center, drill through each 0.1875 inch diameter.

Note C Pretreatment: Pretreat all surfaces IAW MIL-DTL-5541, Type I, Class 1A (Alodine™ 1200s). 40-70mg/sqft

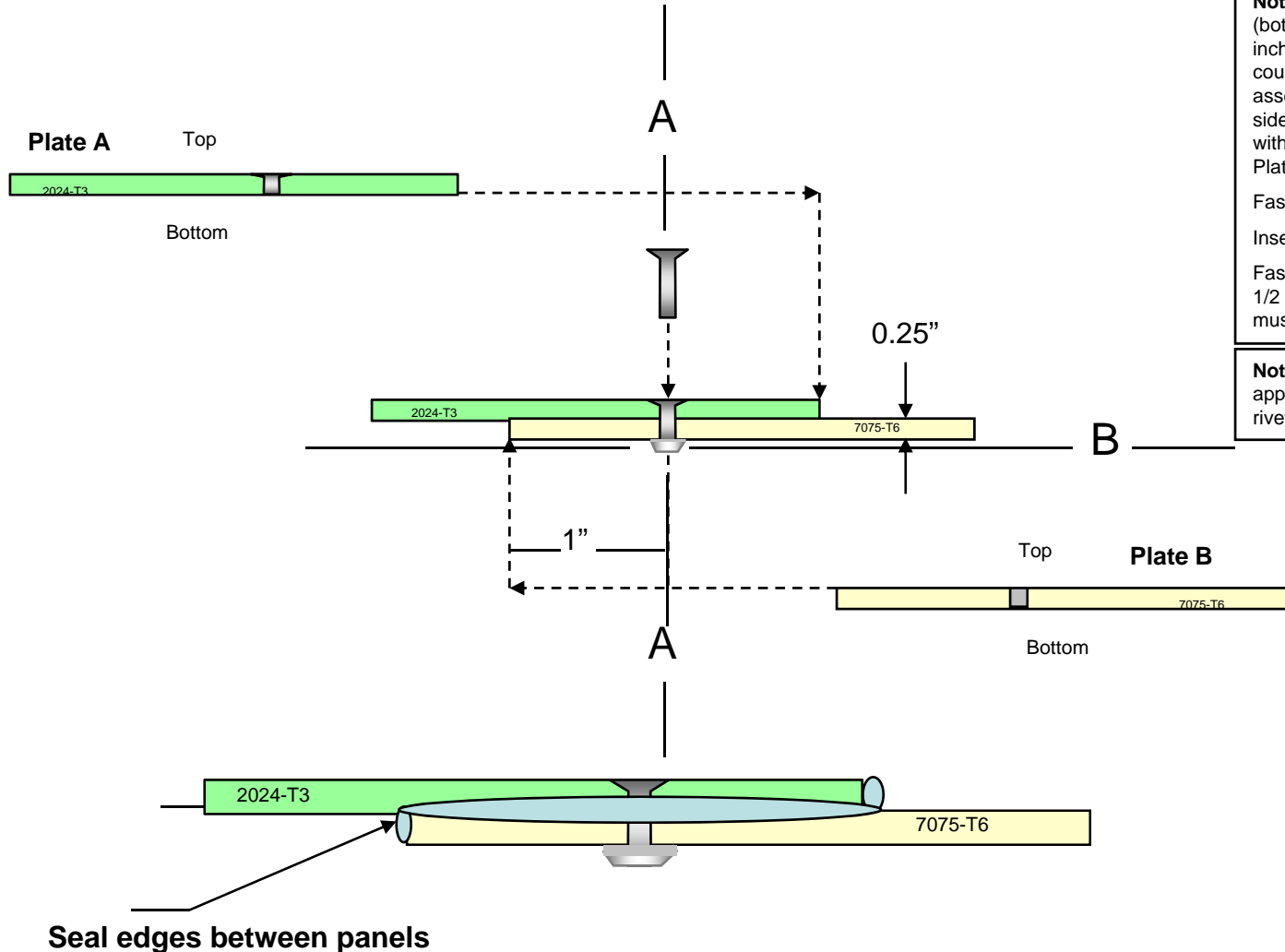
Note D: 1st Prime coat, all top surfaces as shown and edges one (1) coat each to each panel of average thickness of 0.3 mils of MIL-PRF-85582 Type II, Class C1. Measure thickness after priming & record.

Material: Top Plate Al 2024-T3 3inx5inx0.25in thick, Bottom Plate Al 7075-T6 3inx5inx0.25in thick.

Grain direction parallel to short dimension



Dry Install Test Panel: Riveted Assembly



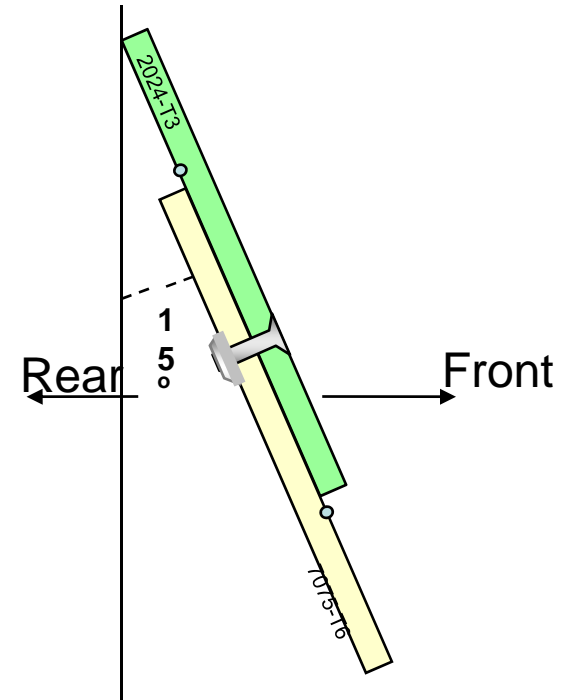
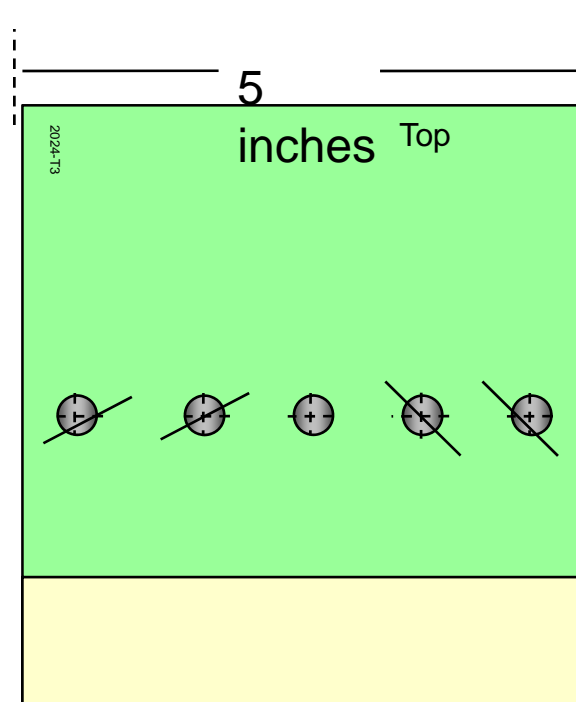
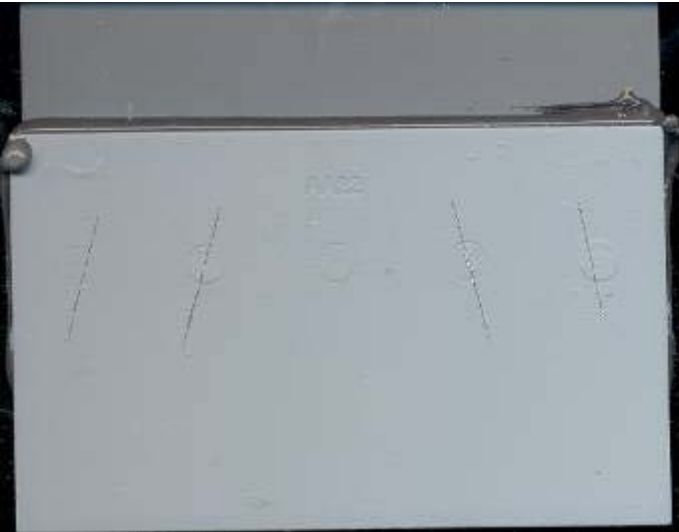
Note A: Assemble Plate A (top) to Plate B (bottom) flush, using MS20426AD5-12 3/16 inch diameter fasteners. Top Plate A, countersink/coated side facing up when assembling. Bottom plate B orientation – coated side up. Coated top of bottom plate B will mate with the uncoated (not painted) bottom side of Plate A.

Fasten per PS19000

Insert and fasten using rivet gun & bucking bar
Fastened rivet back should be approximately 1-1/2 times the diameter of the rivet, evenly mushroomed.

Note B: Fastened rivet back should be approximately 1-1/2 times the diameter of the rivet, evenly mushroomed.

NSF & SO2 Panel Orientation in Cabinet



Orient panels 15 degrees from vertical.

Evaluate per ASTM D 1654-05

Neutral Salt Fog B117– Duration 3000 hours

- Check weekly until 1000 hours
- 1000 hours plus, check every 2 weeks, rate and photograph.
- If a failure occurs – remove, rinse, and photograph or scan panel, and determine the final rating – record.
- Run sets 2800 hours, 5000 hours, & 10,000
- photograph, rate, and scan. Record all data.

168 hours = 1 week/7 days

1000 hours = 41.5 days

3000 hours = 125 days~4 months

SO₂ ASTM G35– Duration 1000 Hours

- If a failure occurs – remove, rinse, and rate, then photograph or scan panel
- At 1000 hours remove 1 set of panels, rate/record, photograph and scan.
- At 2800 hours remove 1 set of panels, rate/record, photograph and scan.
- Run remaining set to 5000 hours.



NAVY AIR ***Accomplishments to Date***

Mar-June

- Panels assembled with candidate fasteners
 - Photographic & Visual documentation
 - Panels placed in SO₂ and Salt Fog
 - Panels shipped for beach exposure testing.
-

June-Oct

- 1000 Hr SO₂ Panels completed, cut for examination and under evaluation
 - SEM analysis performed on Control (current wet install) and Plain (non-coated fastener).
 - Panels placed on beach
 - 2800 Hr SO₂ Panels completed - evaluated
 - 1000 Hr B117 panels complete
-

Oct-Feb

- 2800 Hr B117 Complete – sectioned/being evaluated
 - 5000 Hrs SO₂ Complete- sectioned/being evaluated
-

Feb ->

- 5000 Hrs B117
- 10,000 Hr B117

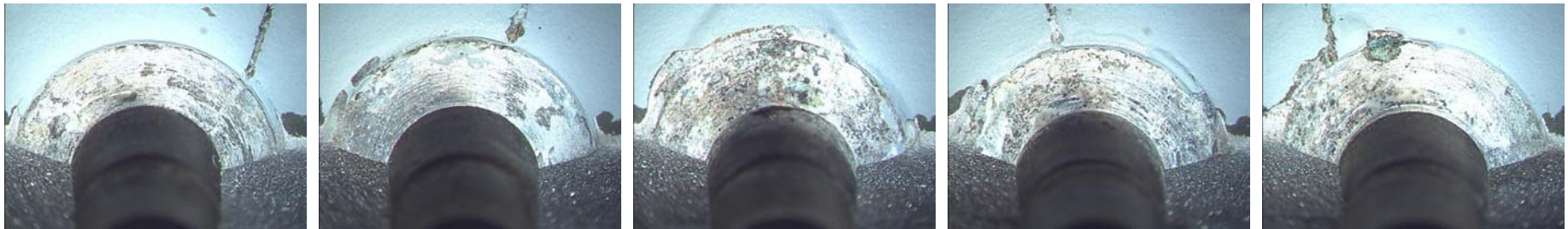


SO2 (G85) Evaluation
1000 Hrs
2856 Hrs





1000 Hours Control- Plain Rivets



17 Weeks Control- Plain Rivets



1000 Hrs SO2 Wet Install



17(2,856 Hrs) weeks Wet Install

Good





1000 Hours Wet Install with Primer Mag Rich



17 Weeks Wet Install with Primer Mag Rich



17 Weeks Control- Plain Rivets





1000 Hours SMRC Product



Not seated

17 Weeks SMRC Product



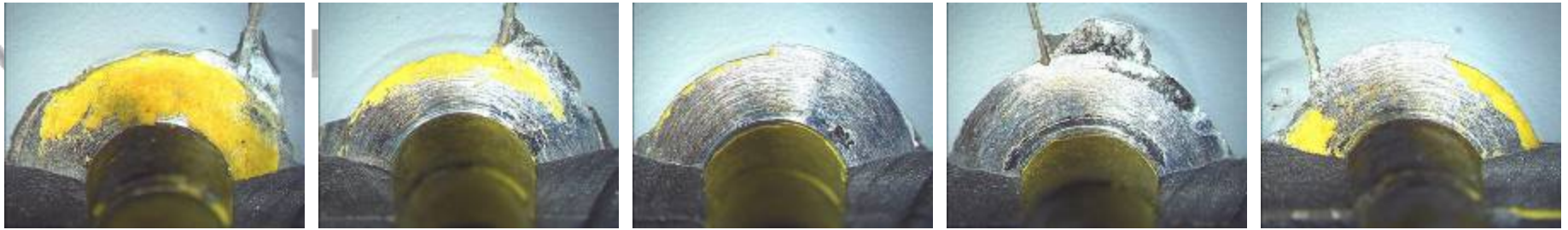
17 Weeks Control- Plain Rivets

Note: Product was precured at time of fastening, fasteners did not seat properly, still performed well-present chromated formulation

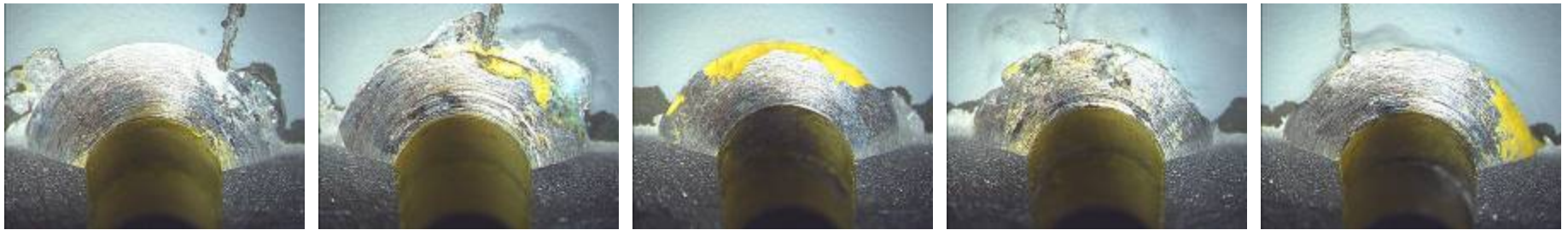


Fair

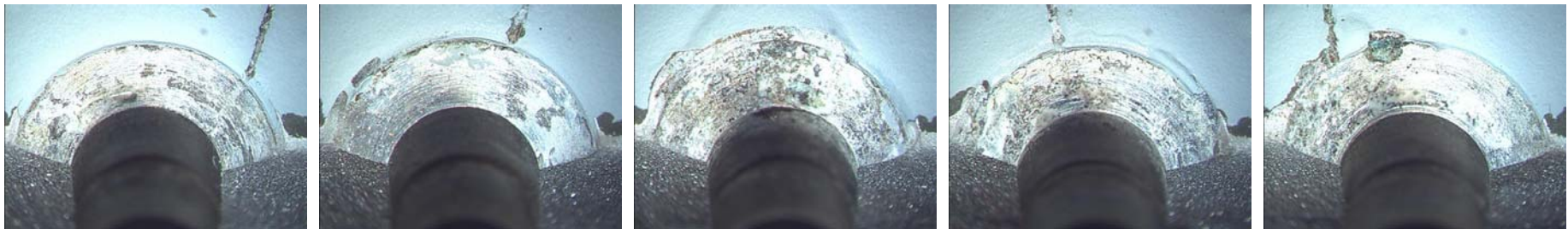




1000 Hours ND Microspheres

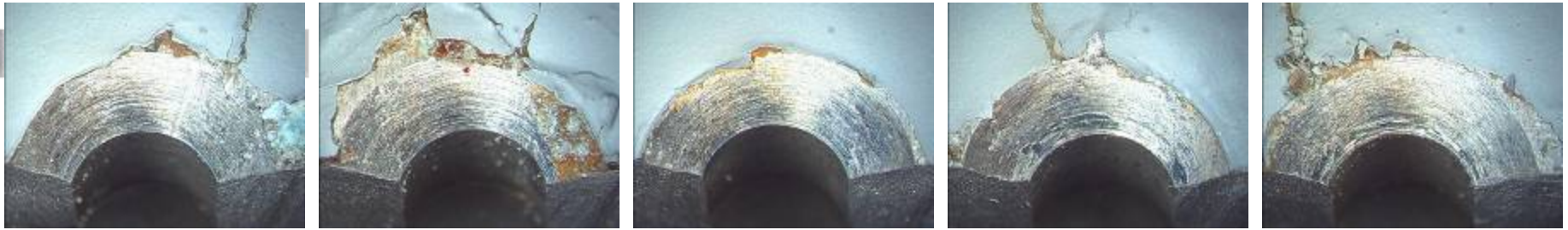


17 Weeks ND Microspheres



17 Weeks Control- Plain Rivets





1000 Hours METSS Product

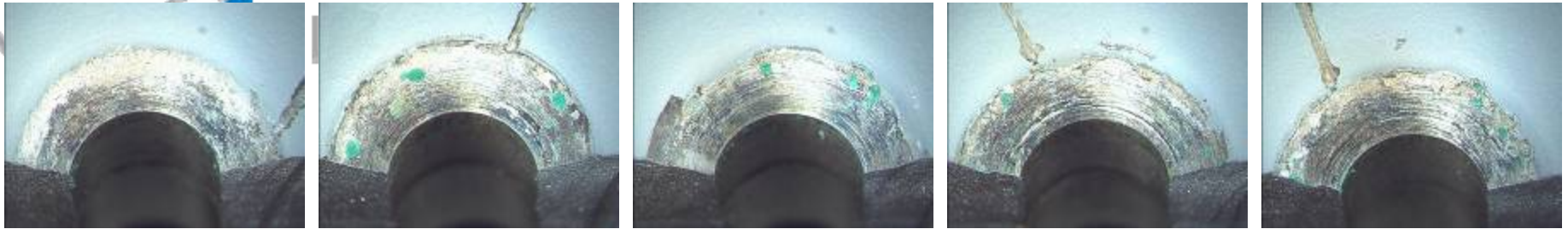


17 Weeks METSS Product

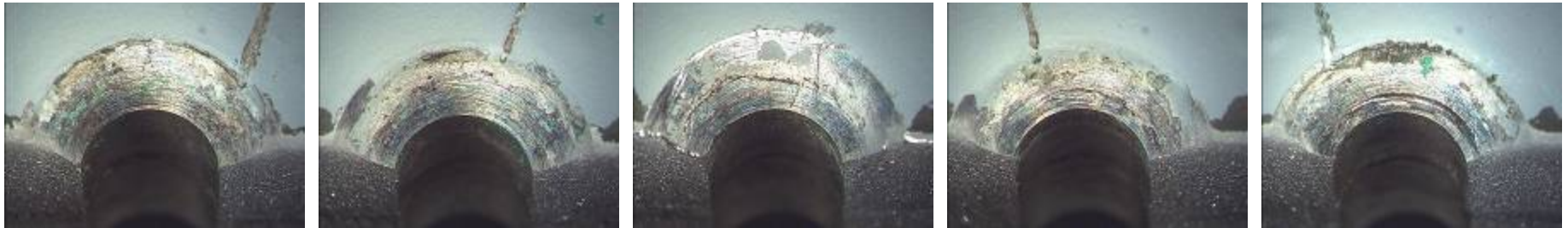


17 Weeks Control- Plain Rivets





1000 Hours NySeal & Magni 565



17 Weeks NySeal & Magni 565

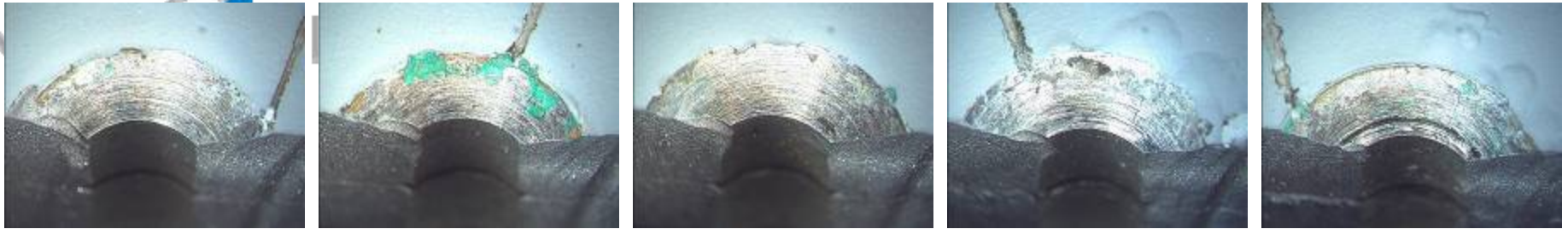


17 Weeks Control- Plain Rivets



Worse





1000 Hours NySeal & Hi-Kote



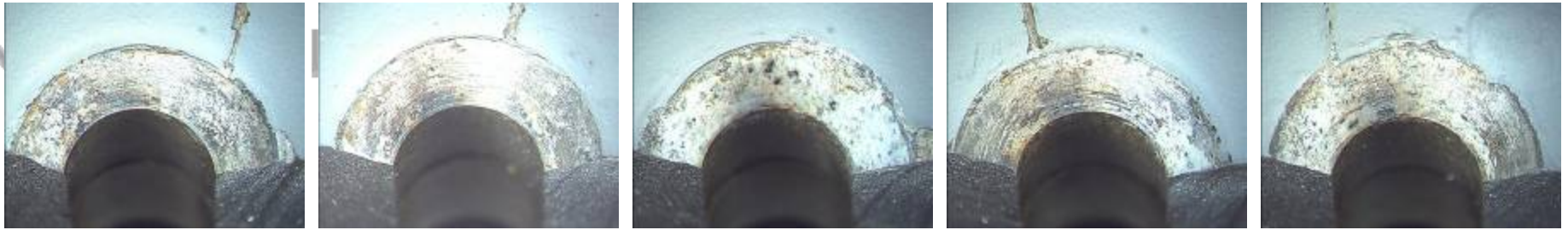
17 Weeks NySeal & Hi-Kote



17 Weeks Control- Plain Rivets

Fastener Head Eaten Away





1000 Hours Hi-Kote 1

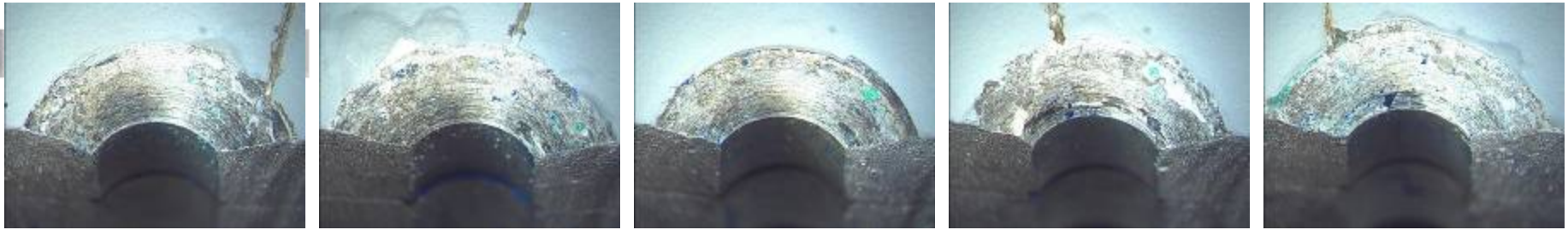


17 Weeks Hi-Kote 1



17 Weeks Control- Plain Rivets





1000 Hours NySeal & Xylan 1424



17 Weeks NySeal & Xylan 1424



17 Weeks Control- Plain Rivets

Fastener Head Eaten Away





1000 Hours NySeal (Green)

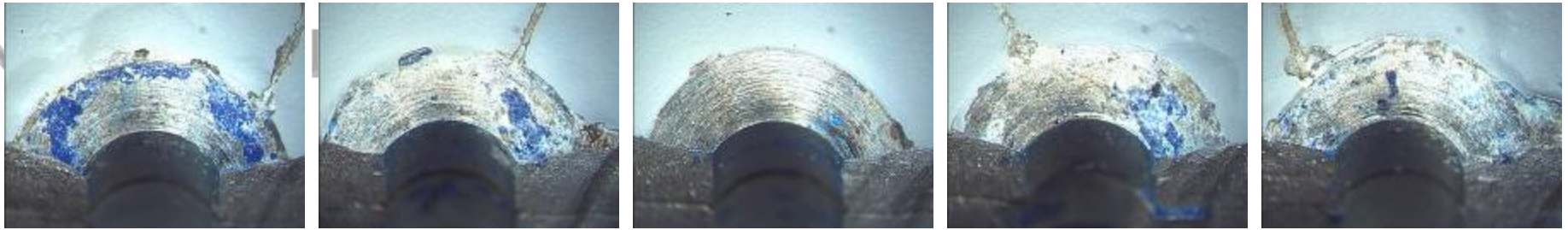


17 Weeks NySeal (Green)



17 Weeks Control- Plain Rivets

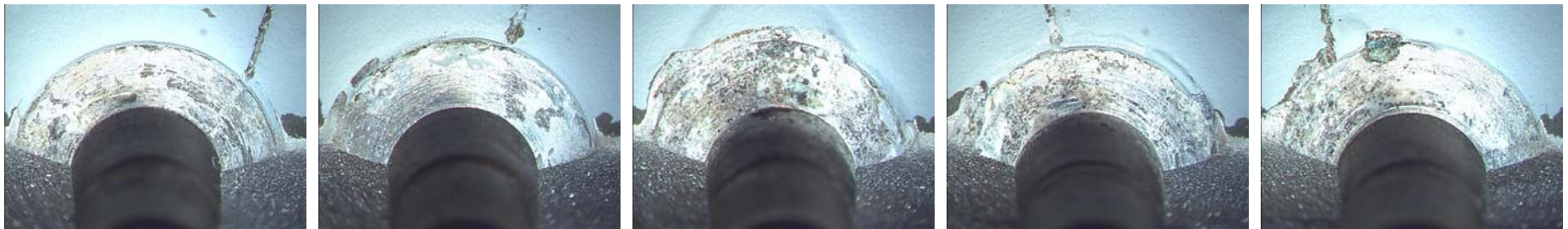




1000 Hours Xylan 1424



17 Weeks Xylan 1424

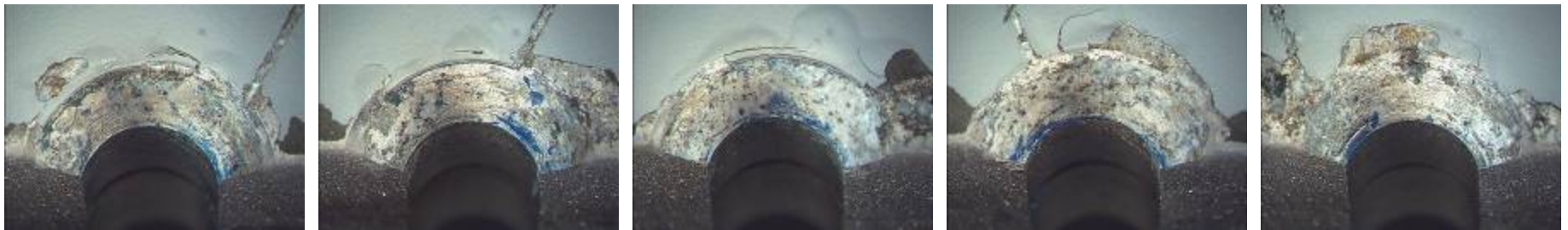


17 Weeks Control- Plain Rivets

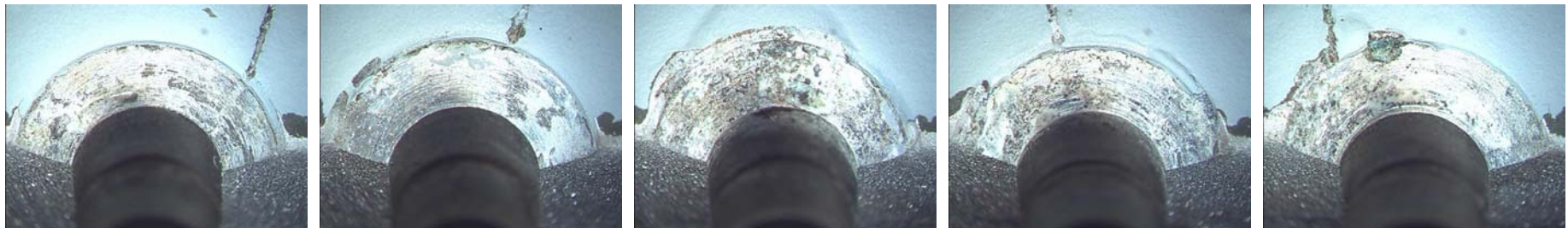




1000 Hours FluorKote 1



17 Weeks FluorKote 1

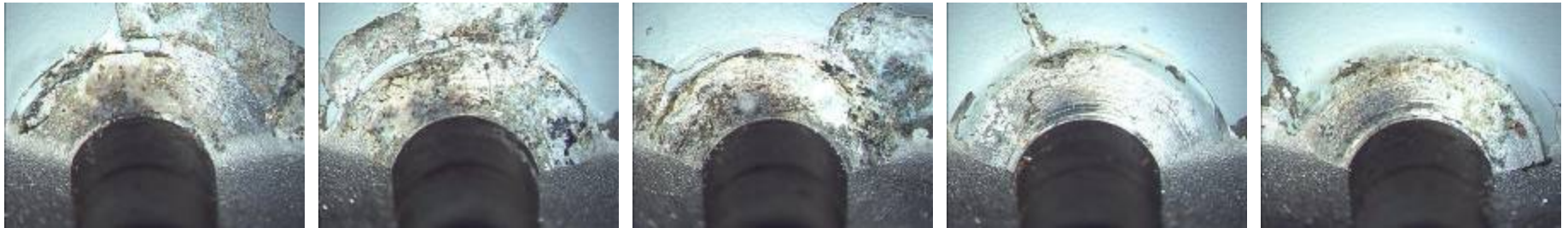


17 Weeks Control- Plain Rivets





1000 Hours Xylan 1070



17 Weeks Xylan 1070

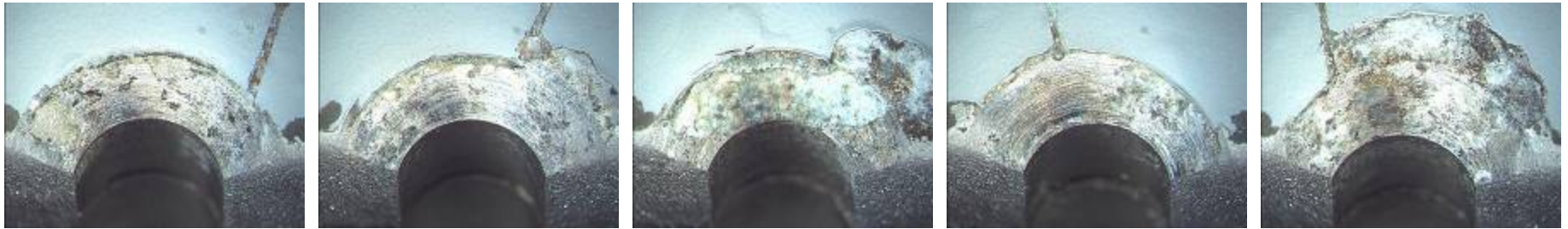


17 Weeks Control- Plain Rivets

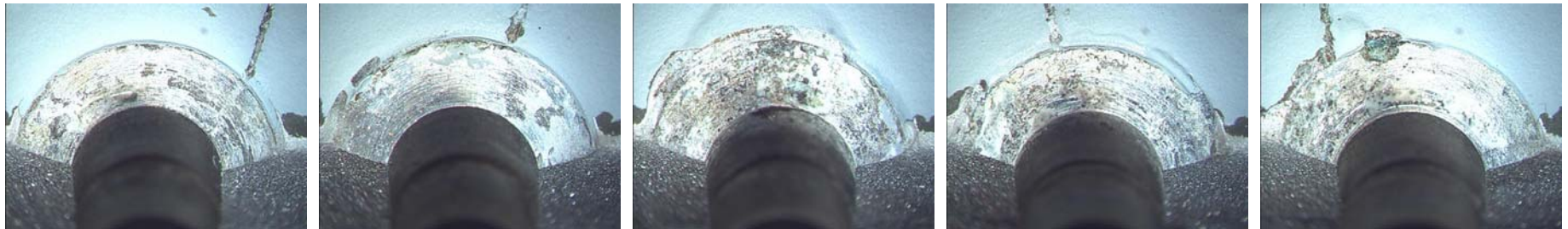




1000 Hours Magni 565



17 Weeks Magni 565



17 Weeks Control- Plain Rivets



- **1000 hour B117 did not tell much**
- **From Samples taken out of SO₂ & 1000 & 2800 Hours**
 - **Fasteners with a coating of said min thickness mitigate crevice corrosion Need some type of corrosion inhibitor over fastener**
 - Coating must fill gap during fastening to mitigate crevice corrosion
 - **Thinly coated products do not mitigate crevice corrosion**
 - **Fasteners without a corrosion inhibitor included in coating**
 - Heavy corrosive attack, usually resulting in degradation of the fastener head.
 - **It appears as if the dry coating fastener approach may produce candidates perform as well or nearly as well as the current wet installation.**

